Effects of Sun Drying and Salting on the Nutritive Value of *Oreochromis niloticus* (Trewavas)

Abeer M. H. Karrar¹, Manal M. A. Awad Elkareem², Samah Mohamed Fadlla Elmula² and Abdel Karim Sabir Ali²

¹National Center for Research, Ministry of Science and Communication, Khartoum-Sudan.

²Department of Biology and Biological Technology, Faculty of Science and Technology, Al Neelain University, Khartoum,

P. O. Box 12702, Sudan.
Abstract:

The aim of this study is to investigate the effect of salting and sun drying on the nutritive value of *Oreochromis niloticus* products. Fresh fish specimens of *O. niloticus* were subjected to salting and drying. Two salt concentrations were experimented: 20 % and 30 % wt/ vol. Fish proximate composition including the determination of moisture, ash, oil and protein contents, fat: protein ratio and caloric values were estimated. In addition, the total bacterial load was identified in the two different salt concentrations. The results which are statistically analyzed showed very clear significant differences in moisture, ash, protein contents and energy value of *Oreochromis niloticus* among the different treatments (*P*<0.05). No significant difference was detected in fat % and fat: protein ratio (*P>*0.05). The microbiological examination revealed that fresh and salted dried products of the *O. niloticus* are within the acceptable levels of the specified microbiological limits recommended by international agencies for fish and fishery products.

**Keywords:** *Oreochromis niloticus*, Fish salting, Fish drying, Nutritive value, Bacterial spoilage.

ملخص الدراسة:

هدفت الدراسة تحديد اثر عملية التجفيف و التملح على القيمة الغذائية لأسماك البلطي النيلي *Oreochromis niloticus* (Trewavas). أجريت الدراسة في الفترة ما بين مارس - مايو 2012، جمعت العينات من سوق الأسماك بالدماران و اضجعت لمعاملات التجفيف و التملح. لتحقيق أهداف الدراسة تم إجراء التحاليل الكيميائية الخاصة بتحديد نسب الرطوبة، الرماد، البروتينات، الدهون و منها تم حساب نسبة الدهون للبروتينات و حسب السترات الحرارية. كما أجريت دراسة ميكروبيولوجية لتحديد النمو البكتيري و بعض أنواع البكتريا في الأسماك الطازجة و المنتجات المملحة.

من نتائج التحليل الإحصائي لنتائج الدراسة تلاحظ وجود فروقات معنوية في محتويات الرطوبة، الرماد، البروتينات و مستويات السترات الحرارية في العينات الطازجة و المملحة (*P*<0.05) بينما لم تظهر فروقات معنوية في محتويات الدهون بالنسبة للبروتينات (*P*>0.05). و كانت كل المقاييس الميكروبيولوجية في العينات الطازجة و المملحة ضمن الحدود المسموح بها غذائيًا للأسماك و منتجاتها بواسطة المنظمات العالمية.
Introduction:

Fish is a very important foodstuff in developing countries, due to its high protein content and nutritional value (Jain and Pathare, 2007). It’s harvesting, handling, processing and distribution provide livelihood for millions of people as well as providing foreign exchange earnings to many countries (Al-Jufaili and Opara, 2006). Fish is an extremely perishable food item (Agbo et al., 2002). Quality loss can occur very rapidly after catch (Khan and Khan, 2001; Musa et al., 2010 and Dewi et al., 2011). Up to 20-25% post – harvest losses occur usually (Ahmed, 2008); sometimes >50% (Ibengwe, 2012) as in Lake Victoria Artisanal Dagaa (Rastrineobola argentea). According to Ruckes, (2003), post-harvest loss amounts to between 10 million and 12 million tones per year. On the other hand, Johnson and Esser (2000) estimated loss of dry fish due to insect infestation is at three million tones. The resultant effect is the decomposition of the fish (Akinola et al., 2006). Spoilage affects the odor, flavor, texture, color and chemical composition of fish (Agbabiaka et al., 2012) and these in turn affect the nutritional quality, consumer acceptability and commercial value of fish (Daramola et al., 2007).

In order to reduce the wastage and spoilage of fish, and to enhance long storage, it is necessary to adopt appropriate as well as affordable processing and preservation techniques for fish especially in the artisanal fishermen’s environment (Oparaku and Ojike 2013). Fish processing helps to extend the storage life of fish and to give the product a form which is attractive to consumers (Tawari and Abowei, 2011). Preservation techniques are designed to inhibit the activity of spoilage bacteria and metabolic changes in order to prevent fish spoilage under prolong shelf life. Some of the preservation techniques are affected through the control of temperature (by chilling or freezing), reduction of water activity (drying, salting and smoking) and use of preservatives (Abolagba and Nuntah, 2011).

Drying dehydrates the fish and inhibits enzymatic action but during storage, nutritional quality may deteriorate as a result of lipid oxidation and microbial growth (Kumolu-Johnson and Ndimele, 2011). According to Shitanda and
Wanjala, (2006), drying reduces or completely eliminates physiological, microbial and enzymatic degradation of biological materials such as fish.

Brining reduces the micro-organisms count on dry fish (Kiaye, 2004), Sodium chloride has traditionally been used in curing and preservation of meat and fish due to its capacity to improve the water holding capacity of proteins (Kituu, et al., 2008).

*Oreochromis niloticus* which is selected for this study is an economically important natural fresh water and cultured species in several areas of the world (El-Husseny et al., 2007 and El-Saidy and Gaber, 2005). It is one of the most important dietary fish in Sudan and amongst the top twenty species of inland water resources of the Sudan they are found in abundance all the year round. They are consumed as fresh or treated products (Karrar, 2007).

The objective of this study was to determine the effects of salting and sun drying on the nutritive value of *Oreochromis niloticus*.

**Materials and Methods:**

26 kilograms of fresh fish specimens i.e. 139 fishes (4-6 fishes = 1kgm) of *Oreochromis niloticus* (Bulti) were obtained for this study from Omdurman fish market (Al Mowrada). This study was carried out during March – May 2012. Fish specimens were washed, descaled, gutted, eviscerated and washed again. A representative sample was taken randomly from the pooled sample to be analyzed and represent the control fresh sample. Then the remaining fish sample was divided into three groups. The first one was subjected to direct sun drying without any predrying treatment. The second and third sub samples were brined for 3 hours in 20% and 30% sodium chloride solution, respectively.

Samples were then dried under direct sun and their weights were recorded daily till constant weights which indicate the completion of the drying process. Dried samples were transformed into powder for lab analysis.

Fresh and dried fish were analyzed to determine the crude protein, fat, moisture and ash content. Crude protein was determined using the Kjeldahl techniques, fat content was determined by using Soxhelt extraction method and ash content was determined by incinerating 1g of sample at 600°C for six hours. Proximate analysis was based on standard methods as described by Pearson (1976) and AOAC (2000). From the fat and protein contents fat to protein ratio was
calculated, and the energy value was calculated using the values 9.02 Kcal/100 gm for fat content and 4.27 Kcal/100 gm for protein content as recommended by FAO (1989). In addition, fresh and dried fish samples were analyzed for the detection, identification and determination of the total viable count of bacteria. *Escherichia coli* and *Salmonella spp.* were identified following the standard methods described by (FAO, 1992). The results obtained were statistically analyzed using one way analysis of variance (ANOVA) and Duncan multiple range tests with significant level (0.05).

**Results and discussion:**

The results obtained from this study focus mainly on the issue considering the effect of salting using two different concentrations of sodium chloride solution (20% and 30% wt/vol) and sun drying on the nutritive value of *Oreochromis niloticus*. Results have shown that all the different treatments followed the same pattern in weight loss during the drying process that started sharply during the first two days, and slowed down gradually till weight remain constant for two successive days indicating the end of the drying process (Figure 1).

![Figure 1: Daily weight loss during drying of fresh and salted *Oreochromis niloticus.*](image-url)
These parameters were taken in consideration during the comparative study of nutritive value of fresh and salted dried fish products. The chemical composition of fish is an important aspect in fish processing as influences both the keeping quality and the technological characteristics of the fish. It is directly related to the moisture, protein, fat and ash contents of the muscle (Huss, 1988).

The initial quality of raw fish material strongly influences subsequent performance in processing and storage. This is true not only for fish but also for all foods. The final quality of the product is the most perfect indicator of the sum of chemical and biochemical changes, which have occurred between the sea and our table. Fish freshness and related quality control problems were studied by Bligh (1971), Jackson (1971), Connell (1975), Osuji (1975), Huss (1988) and Isono (1990). Table (1) illustrated the proximate chemical composition of fresh and dried Oreochromis niloticus products. The results concerning the fresh Oreochromis niloticus chemical composition are coincides with the results reported by Mahmoud (1977), Omer (1984), Awouda (1988) and Karrar (1997).

Table (1): Effect of salting and sun drying on the proximate composition of Oreochromis niloticus

<table>
<thead>
<tr>
<th>Chemical constituent</th>
<th>Control</th>
<th>Fresh dried</th>
<th>20% salted dried</th>
<th>30% salted dried</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture %</td>
<td>71.266(\pm) 2.505</td>
<td>4.351(\pm) 0.512</td>
<td>2.967(\pm) 0.530</td>
<td>2.737(\pm) 0.712</td>
<td>0.000</td>
</tr>
<tr>
<td>Ash %</td>
<td>10.868(\pm) 0.799</td>
<td>13.917(\pm) 1.355</td>
<td>16.351(\pm) 2.214</td>
<td>18.638(\pm) 1.576</td>
<td>0.000</td>
</tr>
<tr>
<td>protein %</td>
<td>71.656(\pm) 2.851</td>
<td>64.612(\pm) 3.178</td>
<td>67.788(\pm) 2.748</td>
<td>67.425(\pm) 2.957</td>
<td>0.005</td>
</tr>
<tr>
<td>Fat %</td>
<td>1.865 (\pm) 13.835</td>
<td>15.305 (\pm) 2.338</td>
<td>13.542 (\pm) 1.338</td>
<td>12.467 (\pm) 1.936</td>
<td>0.072</td>
</tr>
<tr>
<td>Fat : Protein Ratio</td>
<td>0.1977 (\pm) 0.0319</td>
<td>0.2386 (\pm) 0.04722</td>
<td>0.20007 (\pm) 0.02123</td>
<td>0.1856 (\pm) 0.0337</td>
<td>0.054</td>
</tr>
<tr>
<td>Energy Value Kcal/100gm</td>
<td>415.750&lt;sup&gt;a&lt;/sup&gt; ±9.8018</td>
<td>398.25&lt;sup&gt;b&lt;/sup&gt; ±12.4771</td>
<td>395.14&lt;sup&gt;b&lt;/sup&gt; ±16.1004</td>
<td>383.97&lt;sup&gt;b&lt;/sup&gt; ±16.7113</td>
<td>0.010</td>
</tr>
</tbody>
</table>

* Means with similar superscript (in a row) are not statistically significantly different (p > 0.05), those with different superscript are statistically significantly different (p < 0.05).

Results showed clear reduction in moisture content of fish due to drying process. Whereas slight decrease in moisture content with the increase in the brine concentration was observed (figure 2), this is consistent with the observations by Mujaffar and Sankat (2006), Sereno et al. (2006) and Kituu et al. (2008). This can be explained by the fact that since salt is hygroscopic; increase in its concentration will increases the amount of salt particles for absorbing water molecules from the fish samples (Graivier et al., 2006).

![Figure 2: Moisture content of fresh and dried Oreochromis niloticus](image)

Ash content shows clear significance differences among the different treatments (figure 3). Increased values in salted dried samples could be attributed to the salting process; these results were in accordance with (Ahmed, 2006 and Bakhiet and Khogalie, 2012).
Protein content was highly significantly different among the different treatments (P<0.05) as shown in figure (4). The recorded reduction in protein level in salted products could be attributed to the fact that the protein being dissolved in the brine (Clucas and Ward, 1996). These results agreed with the findings of Ufodike and Obureke (1989) and Arekemase et al (2012) whereas this was in disagreement with Mohamed (2008) who mentioned an increase in protein content of fish with the addition of salt.
Fat content was not affected by the different treatments (P>0.05) (figure 5). This is in agreement with Hughes et al. (1980) and Shearer (1994) who stated that lipid content of fish varies only with seasonal and physiological factors.

Bacterial growth is the main cause of fish spoilage; therefore it is logical to use bacterial count as an index of fish quality. In this study the total number of bacterial count for fresh and dried Oreochromis niloticus (table 2) was within the accepted limits mentioned by SSMO (SDS 357) which were $5 \times 10^5$ – $10^6$ cfu/gm for fresh fish products. Also this number was in the normal range stated by Liston (1980) which was $10^2$ – $10^7$ cfu/g of fish meat. It was reported that the bacterial flora on freshly caught fish depends on environment rather than fish species, and this reflects the wide range of bacterial count in fish and fishery products (Shewan, 1977). Result shows the effect of salting process in inhibiting the growth of some bacterial species; this is in agreement with (Yanar, et al, 2006).
Table (2): Total viable bacterial count and presence of some dominant microbial species in dried *Oreochromis niloticus*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total Bacterial count cfu /1 ml</th>
<th>Total Coliforms</th>
<th><em>E. coli</em></th>
<th><em>Salmonella.</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>$4.98 \times 10^3$</td>
<td>-ve</td>
<td>-ve</td>
<td>-ve</td>
</tr>
<tr>
<td>Fresh dried</td>
<td>$6.14 \times 10^3$</td>
<td>+ve</td>
<td>+ve</td>
<td>-ve</td>
</tr>
<tr>
<td>20% salted dried</td>
<td>$5.46 \times 10^3$</td>
<td>-ve</td>
<td>-ve</td>
<td>-ve</td>
</tr>
<tr>
<td>30% salted dried</td>
<td>$5.04 \times 10^3$</td>
<td>-ve</td>
<td>-ve</td>
<td>-ve</td>
</tr>
</tbody>
</table>

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